

Book Reviews

PALEOCLIMATE AND EVOLUTION, WITH EMPHASIS ON HUMAN ORIGINS Edited by Elisabeth S. Vrba, George H. Denton, Timothy C. Partridge, and Lloyd H. Burckle. 1996. New Haven, CT: Yale University Press. 547 pp. ISBN 0-300-06348-2. \$85.00 (cloth).

Since 1984, the editors of this book have organized three major workshops on climate and evolution. Practice makes perfect. This splendid volume is the result of a conference held in May, 1993, at Airlie, Virginia, that was devoted to testing the general relationship between evolution and climate change. Although at least one chapter deals with every continent and the time considered ranges from the Oligocene to the Holocene, the Plio/Pleistocene of Africa receives special attention here, because human evolution is emphasized. Researchers with diverse specializations in geology, climatology, and paleontology have been assembled, and the editors have ensured that these writers strictly address the major theme of the conference. A dominant feature of the book is the presence of abundant original data; detailed taxonomic and methodological appendices also conclude many chapters.

Some authors deal with regional climate and evolution in terms of a specific animal group—for example, large herbivores (Webb et al.), bovids (Vrba), suids (White), rodents (Wesselman), and micromammals (Avery). Other authors provide major new syntheses of crucial interest to physical anthropologists—for example, terrestrial faunal diversity in the Neogene of Pakistan (Barry), the impact of global climate and regional tectonic changes on large mammal evolution in East and South Africa (Partridge et al.), paleoclimate in the Turkana Basin and throughout East Africa (Brown), and faunal and environmental change in the Tugen Hills, Kenya (Hill). Bonnefille presents the first synthesis in a decade of the East Afri-

can Plio/Pleistocene pollen record. With a data set of 120 pollen spectra over 4 million years, she excludes local and aquatic taxa, uses modern pollen data (not modern plant communities) for regional vs. local comparison, and concludes that palynological evidence documents no trend for increasing aridity and the spread of grasslands at hominid sites.

Chapters by Bar-Yosef, Brain, Kimbel, Pope, Rightmire, Stringer, and Wood that deal specifically with hominid evolution generally contain no novel information for readers of this journal; the authors have already published this material in journal articles that will be very familiar to physical anthropologists. However, a useful array of chapters addresses important geological factors that may not be well known to physical anthropologists. Two chapters synthesize the evidence of global climate from the middle Miocene through the Pleistocene, using tectonics and volcanism (Partridge et al.) and marine sediments (Kennett). The establishment of ice sheets at both poles beginning 3 mya resulted in widespread aridity in low to middle latitudes. The impact of glaciation and fluctuating global sea levels on mammal migration is also considered (Opdyke). Pliocene climatic variability, and whether a climatic Pliocene Golden Age truly occurred or is merely apocryphal, is discussed by many authors. The Pliocene stability of the East Antarctic ice sheet is currently highly controversial. The question of ice sheet stability affects whether Pliocene climate in Antarctica was polar or temperate and thus affects every reconstruction made of global climate and sea level during the Pliocene. Denton presents these two contrasting views of Antarctic history and cautions that each has a fundamentally different impact on global paleoenvironments during the Pliocene. Kennett and Burckle strongly favor the view that the East Antarctic ice sheet has been stable since the middle Miocene (14 mya); although the early Pliocene was warmer than the late Pliocene, no meltdown of the East Antarctic ice sheet

took place. Shackleton presents extensive new radiometric and oxygen isotope data on Pliocene climate from seafloor sediments. There are two major conclusions of this paper. The first is that there was extensive climatic variability even within the Pliocene Golden Age (here calibrated to 3.6–3.3 mya). The second is that astronomical forcing of climate is documented in the extensive benthic record; a 41,000 year cycle is apparent after 3.0–2.6 mya, and a 100,000 year cycle is apparent after 900,000 years, when the principal rhythm of the continental ice sheets was established. The intensity of glaciation mounted gradually rather than intensifying suddenly. Shackleton's conclusions impact on most of the other chapters in the book.

E.S. Vrba, the senior editor, contributes two chapters. One, dealing with African bovids, reaffirms her previous judgment that climatic cooling at 2.7–2.5 mya had a major impact on the evolution of this group and also concludes that the development of larger body size and the retention of juvenile morphology in these species are caused by climatic deterioration. Vrba's second chapter is the centerpiece of the book, because it articulates the hypothesis of paleoclimatic forcing of organismal evolution (the turnover pulse hypothesis), the testing of which was the *raison d'être* of this conference. An appendix summarizes previous accounts of the turnover pulse hypothesis, which is now expanded and revised. Vrba here defines habitat as the fundamental basis of the hypothesis; that is, habitat-driven forces are the principal cause of speciation, extinction, and migration. She sees competition-driven forces as the competing explanation for biological change. Vrba believes that the two general types of explanation are mutually exclusive. Two paradigms exist: there is a "competition- and habitat-based dichotomy." "Is physical change the necessary pace-maker of speciations and extinctions, or do living entities drive themselves to evolve and disappear even in its absence?" (p. 24). Besides creating this false dichotomy, Vrba then misrepresents competition-based interaction as some unknown, almost vitalistic process: "According to some models . . . this biotic force at the level of organisms con-

stantly works toward speciation and extinction, irrespective of population structure and even in the absence of physical change. That is, the biota is akin to a perpetual motion machine that inexorably drives itself to evolution" (p. 25). Vrba's habitat theory assumes that natural selection is weak, competition is excluded, and allopatry is not sufficient to create new species without the additional element of climatic forcing. There is no discussion about the lag time anticipated between climate change and evolutionary events, except that speciation is always assumed to be slower than extinction, which is nearly always fast. Other chapters demonstrate that no clear turnover clusters occur among Plio/Pleistocene mammals; different groups (e.g., African bovids, suids, hominids) have different sensitivities to climatic events. Furthermore, major turnover events can occur without discernible regional or global climatic triggers (e.g., Miocene artiodactyls and rodents of Pakistan).

Vrba also presents two important evolutionary models in this chapter. The "traffic light" model explains why major vectors exist in land mammal migration. Rapoport's Rule (uncited by Vrba), which documents larger home ranges in temperate than in tropical species, seems to be the real explanation here (Stevens, 1989). The "relay model" of speciation assumes that continuous, long-term vicariance and extended shifts in the astronomical forcing of climate should create a relay pattern in turnover events. Vrba here sets species into warm- or cold-adapted categories and seems to assume that tolerances will not change. Furthermore, community composition is also assumed to be rigid (there is a warm or a cold community), yet current work by the FAUNMAP group documents how heterogeneous and plastic ancient communities truly were in Pleistocene North America (Graham et al., 1996).

A major chapter by deMenocal and Bloemendal contains great amounts of data on aeolian dust from seafloor sediments and inferences about climatic aridity in Africa. In addition, a general circulation model is presented to test the sensitivity of subtropical African and Asian climate to climatic changes in high latitudes. The authors con-

clude that East Africa, Arabia, and South-western Asia respond to high-latitude ice cover, but these areas are especially sensitive to sea surface temperature in the North Atlantic.

In summary, the editors of this volume wonderfully concentrate the efforts of contributors on the theme of paleoclimate and evolution. Such concentration is unique in recent years in books that result from conference proceedings. Many of the chapters contain original data, major syntheses, or extended arguments unlikely to be published elsewhere. This book is a major contribution to paleoclimate reconstruction and evolution-

ary theory and is likely to remain a landmark in these fields.

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